C I A!

Challenging **I**nvestigations in **A**rt forgery

ANSWER SHEET

30th of April 2015

Challenge 2

Country:

Team:

Names and signatures

_____

_____

_____

TASK A

1. Assignments to be done with the pieces of evidence.

1.1. Which pieces of evidence from the bag "Mix" belong to which potential location? Write the appropriate numbers of the pieces of evidence from the bag "Mix" in the table next to the corresponding studio location. (8 Marks)

Pieces of evidence from the bag "Mix"	
Lakeside studio	
Forest studio	
Seaside studio	

1.2. Systematic assignment: Fill in the numbers found on the pieces of evidence and clearly write them into the appropriate blanks in the tables "Systematics 1" and "Systematics 2"!

Table "Systematics 1"			(11 Marks)
Family Familia		Genus (first part of species name)	
1 mark for a correct answer		1 mark for a correct answer	
Yew family Taxaceae		Yew *Taxus*	
Pine family Pinaceae		Fir tree *Abies*	
		Larch *Larix*	
		Spruce *Picea*	
		Pine *Pinus*	
Cypress family Cupressaceae		Cedar/Juniper *Juniperus*	
Rush family Juncaceae		Rush/Juncus *Juncus*	
		Woodrush *Luzula*	
Sweet grasses Poaceae		Barley *Hordeum*	
		Wheat *Triticum*	
Sedge family Cyperaceae		Carex *Carex*	
Birch family Betulaceae		Alder *Alnus.*	
		Hornbeam *Carpinus*	
		Birch *Betula*	
Ice plant family Aizoaceae		Ice plant *Mesembryanthemum*	**9**

Table "Systematics 2" (10 Marks)

	0,5 marks for a correct answer		1 mark for a correct answer	
Class Classis	Order Ordo		Family Familia	Genus Genus
Mussels Bivalvia			Zebra mussels Dreissenidae	Zebra mussel *Dreissena sp.*
			Freshwater mussels Unionidae	Swan mussel *Anodonta sp.*
Snails Gastropoda			Abalones Haliotidae	Abalone *Haliotis sp.*
			Limpet Patellidae	Limpet *Patella sp.*
Crayfish Malacostraca		Wood louses Isopoda		
Spiders Arachnida		Spiders Aranea		
Insects Insecta		Beetles Coleoptera		
		Hymenoptera	Wasps Vespidae	Wasp *Vespa sp.*
			Ants Formicidae	Ant *Formica sp.*
			Bees Apidae	Bee *Apis sp.*
		True bugs Heteroptera		

2. Mesembryanthemum crystallinum

2.1. Shape of the embedded crystals (7 Marks)

2.1.1. Fill in the appropriate letter into the answer box!

Show the prepared microscope slide to the laboratory assistant!

For the laboratory assistant:

Crystals are visible in the object. Tick appropriate!

Yes ☐

No ☐

Signature of the laboratory assistant**:** _____

2.2. Distinction between Calcium oxalate- and Calcium carbonate crystals

2.2.1. **Tick the result of your investigation** (3 Marks)

Table "Reaction of crystals"	
Reaction of crystals with hydrochloric acid:	**Result of investigation:**
Do not dissolve in hydrochloric acid.	
Dissolve in hydrochloric acid with bubbles.	
Dissolve in hydrochloric acid without bubbles.	

In the left column is a statement, in the right column ➔ tick

2.2.2. **The conclusion of your investigation** (2 Marks)

Choose the appropriate letter and write it into the answer box!

2.3. Investigation of NaCl in bladder cells.

2.3.1. Analysis of chloride ions (4 Marks)

Table ”Analysis of chloride ions“		
This can be seen:	**Conclusion:**	**Tick appropriate!**
There is no change to be seen.	Chloride ions are present in the liquid of epidermal bladder cells.	
	There are no chloride ions present in the liquid of epidermal bladder cells.	
A white precipitate forms.	Chloride ions are present in the liquid of epidermal bladder cells.	
	There are no chloride ions present in the liquid of epidermal bladder cells.	

2.3.2 **Analysis of sodium ions** (3 Marks)

Table “Analysis of sodium ions”		
This can be seen:	Conclusion:	**Tick appropriate!**
Flame coloration (tick the correct colour): ☐ Yellow ☐ Green ☐ Blue ☐ Red	Sodium ions are present in the liquid of epidermal bladder cells.	
	There are no sodium ions in the liquid of epidermal bladder cells.	

2.3.3 **Possible sources of error during flame test** (1 Mark)

Table “Possible sources of error during flame test”		
Source of error	**Applies**	**Not applicable**
Contamination of magnesia stick with sodium		
Sweat		

2.4. The results from the investigation of *Mesembryanthemum* from the car

2.4.1. Summarize your results from your investigation in the checklist "*Mesembryanthemum*" (0 Marks)

Checklist "*Mesembryanthemum*"		
Shape of crystals in cells	Crystal sand	
	Single crystals	
	Raphides	
	Crystal druses	
Material of the crystals	Calcium carbonate	
	Calcium oxalate	
NaCl present in the liquid of epidermal bladder cells	Yes:	
	No:	
Optical activity	Yes:	
	No:	

2.4.2 **Write the correct name of the plant found in the car into the answer box!** (4 Marks)

3. Graphical presentation of epidermal cells and cells of the stomata. (12 Marks)

4. Crude examination of the small stone from the car

4.1. **Tick the appropriate answers!** (5 Marks)

Examination of the stone found in the car		
	Correct	Incorrect
It is harder than glass (microscope slide).		
Bubbles produced by the addition of water droplets on the stone.		
Significant colour change by the addition of water droplets on the stone.		
Bubbles produced by the addition of hydrochloric acid on the stone.		
Significant colour change by the addition of hydrochloric acid on the stone.		

4.2. **Result of crude determination: Write the appropriate letter into the answer box!** (2 Marks)

5. Bag from the car

Identify the studio, the pieces of evidence from the car belong to.

5.1 Tick the appropriate box in the following table from which studio the pieces of evidence found in the car might be from. (3 Marks)

Pieces of evidence from the bag from the car	
Studio	**Labelled pieces of evidence**
Seaside	
Lakeside	
Forest	

6. Who is responsible for the art forgery?

Tick the most likely location the fraudulent painting could have come from in the following table! (3 Marks)

Forest studio	
Lakeside studio	
Seaside studio	

7. Plant metabolism

Fill in the appropriate numbers in the table "Plant metabolism". (14 Marks)
1 = appropriate statement 0 = not applicable

Table "Plant metabolism"			
	C3 plants	C4 plants	CAM plants
The oxygen that is released during photosynthesis comes from CO_2.			
The oxygen that is released during photosynthesis comes from H_2O.			
Usually, the stomata are open during the night.			
Usually, the stomata are open during the day.			
The first product of CO_2 fixation is a compound with 4 carbon atoms.			
Maize is part of this group of plants.			
Most plants are part of this group.			

TASK B

1. Investigation of paint samples

1.1. Detection with luminol

1.1.1. **Record your observations in the table.** (6 Marks)

Fill in the table. Write **"P"** for a positive test and **"N"** for a negative test.

S 1	S 2	S 3

1.1.2. **What colour of light do you observe, if the test is positive?** (1 Mark)

Tick the appropriate answer.

- ☐ blue
- ☐ green
- ☐ red/orange

1.1.3. What is the reason for the light emission? **(**1 Mark)

Tick the appropriate answer.

- ☐ phosphorescence
- ☐ fluorescence
- ☐ chemoluminescence

1.2. Spot plate (19 Marks)

1.2.1. Show the finished spot plate to the laboratory assistant who will take a photo.

For the laboratory assistant:

Spot plate has been photographed.

Signature of laboratory assistant: _____

1.2.2. Which of the samples contain Fe(III)? Record your findings in the table. (6 Marks)
Fill in the table. Write **"P"** for a positive test and **"N"** for a negative test.

S 1	S 2	S 3

1.2.3. Based on the tests you have conducted so far, which sample(s) might contain blood?
Fill in the table. Write **"P"** if you assume it contains blood and **"N"** if you assume it does not.
(6 Marks)

S 1	S 2	S 3

1.3. Detection of haemoglobin with Teichmann test

1.3.1. **Which samples contain Teichmann crystals**? (6 Marks)
For reference, use the picture of what Teichmann crystals look like next to the microscope.
Fill in the table with **"P "** if it contains Teichmann crystals or **"N"** if it does not contain them.

S 1	S 2	S 3

1.3.2. Show one sample that contains Teichmann crystals to the laboratory assistant.
(4 Marks)
Get the laboratory assistant's signature for confirmation.
Put the labelled slides into the envelope and make sure that you hand it in with the answer sheet.

For the laboratory assistant:
Teichmann crystals present ☐ not present ☐

Slides submitted.

Signature of the laboratory assistant: _____

2. Investigation of canvas

2.1. **Calculate the Rf-value for chloride**. (13 Marks)

Calculation:

Attach the chromatogram!

Chromatogram:

2.2. In which of the samples have you found chloride? (6 Marks)
Fill in the table. Write "**P**" for a positive test and **"N"** for a negative test.

A	B	C

2.3. Summarize your findings.

2.3.1. **The origin of the painting can only be a studio where blood is used**. (2 Marks)
Tick "**yes"** or "**no".**

- ☐ Yes, blood was used
- ☐ No, blood was not used

2.3.2. The origin of the painting can only be a studio with an increased concentration of chloride. (2 Marks)
Tick "**yes"** or "**no".**

- ☐ yes
- ☐ no

2.3.3 Based on your findings, which of the studios might the painting originate from? (6 Marks)
Fill in the table. Write **"P"** if the studio is possible and **"N"** if the studio is not possible.

Studio in the forest	Studio at the Lake	Studio at the sea

3 Theoretical assignment

3.1 Tick the appropriate answers. (8 Marks)

		correct	incorrect
3.1.1.	The Rf-value changes depending on the time the plate is left in the TLC-chamber.		
3.1.2.	In order to achieve luminescence, electrons always have to be excited by a chemical reaction.		
3.1.3.	The iron in the haem complex acts as a catalyst in the luminol reaction performed in this task.		
3.1.4.	In the reaction of iron ions with SCN^- the iron ions are being oxidized.		

3.2 At a 40-fold magnification a crystal appears to be 2 cm long. How big is it in reality? (6 Marks)

Calculation:

Task C

1. Measurement of the wavelength of a laser

1.1. Determine the angle α between the 0th and 1st order maximum. (3 Marks)

You need to know the distance from grid to floor L and between the two marks on the black paper X (Fig. 1.2).

Formula for α:

Angle α = degree

1.2. Calculate the grating constant d, i.e. the distance between two lines on the grid. Give the answer in the unit of metre. (3 Marks)

Grating constant d = m

1.3. Wavelength of the laser (6 Marks)

Write the transposed formula used for wavelength determination. Calculate the wavelength of the light for the 1st maximum (n = 1) using your measured values.

λ =

λ = m ·λ = nm

2. Investigation of textures (10 Marks)

2.1. Determination of the diffraction angle of textures A – E

Table 2.1a			
texture	**distance L**	**distance X**	**angle α (degree)**
A			
A			
A			
B			
B			
B			
C			
C			
C			
D			
D			
D			
E			
E			
E			

Table 2.1b		
textures	**mean value of the angle (degree)**	**standard deviation (degree)**
A		
B		
C		
D		
E		

2.2. Diagram: texture A - E – diffraction angle (10 Marks)

Paste your diagram!

2.3. Possible forger studios

Insert the diffraction angle (3 Marks)

Table 2.3			
sample	**distance L**	**distance X**	**angle α (degree)**
P			
P			
P			

Diffraction angle of sample P: α = degree (mean value and standard deviation)

Possible studios of the forgery:

3. Identification of a fluid

3.1. Adjustment of the experiment

Write down the value of the zero reference mark! (1 Mark)

Value of the zero reference mark: …… degree

3.2. Which fluid shows optical activity?

Insert your result in the table 3.2! (3 Marks)

Table 3.2		
fluid sample	**yes**	**no**
A		
B		
C		

Confirmation by the lab assistant:

3.3. Measurement of the optical activity at different concentrations (8 Marks)

Table 3.3a		
dilution	**concentration [g/100ml]**	**rotation angle α [degree]**
original	50	
original	50	
original	50	
1	25	
1	25	
1	25	
2	12,50	
2	12,50	
2	12,50	
3	6,25	
3	6,25	
3	6,25	

Calculate the mean value and the standard deviation.

Table 3.3b			
dilution	**concentration [g/100 ml]**	**mean value of the rotation angle α [degree]**	**standard deviation [degree]**
original	50		
1	25		
2	12,50		
3	6,25		

3.4. Set up of a calibration graph for the optical rotation (10 Marks)

Draw a diagram on a millimeter paper, in which the rotation angles α are plotted in relation to the concentration. Insert this diagram here! Be sure to include mean values, error bars and a line of best fit!

3.5. Determination of the specific rotation angles (8 Marks)

Table 3.5			
dilution	**concentration [g/100 ml]**	**specific rotation angle [α] [degree.ml/dm.g]**	**standard deviation [degree.ml/dm.g]**
original	50		
1	25		
2	12,50		
3	6,25		

3.6. Diagram: Specific rotation angle in relation to the concentration (10 Marks)

3.7. Interpretation of the results (9 Marks)

Tick the appropriate answers for your experiment!

Table 3.7	Correct	Wrong
The constant function is based on the fact that the specific rotation angle of a substance is independent of the concentration.		
The increase of the concentration leads to smaller values of the specific rotation angle.		
The uncertainties of the measured values arise from inaccurate measurements of the angle.		
The uncertainties of the measured values arise from inaccurate dilutions.		
The uncertainties of the measured values arise from varying intensities of the laser.		
The uncertainties of the measured values arise from the wavelength of the laser.		
The uncertainties of the measured values arise from the measuring process.		
The uncertainties of the measured values can be reduced in drawing a line of best fit.		
The uncertainties of the measured values can be reduced by additional measurements.		

3.8. Determination of the substance (6 Marks)

3.8.1. The specific rotation angle [α] = degree

3.8.2. Select the substance which has a specific rotation angle closest to your result! Tick the appropriate answers!

Table 3.8		
material	**yes**	**no**
fructose		
glucose		
saccharose		
tartaric acid		
ascorbic acid		

Possible studios of the forgery (2 Marks)

3.9. Identification of the studio/s

Possible studio/s of the forgery:

TASK D

1. The investigator team's conclusions

1.1. Fill in "Y" (applicable) or "N" (not applicable/wrong) in the table.

(0 Marks)

Table "Investigator team's summary"

Methods of investigations	Studio in the forest	Studio at the sea	Studio at the lake
Chemical analyses of the art studios' samples			
Optical activity investigation of the liquid of *Mesembryanthemum crystallinum* bladder cells			
Visual investigation of the canvas sample			
Investigation of *Mesembryanthemum crystallinum*			
Investigation of the pieces of evidence from the car trunk			

1.2. Indicate your common statement in the table "<u>Investigator</u> team's conclusion" with an "X" in the relevant field! (6 Marks)

Table “ Investigator team’s conclusion“		
According to the scientific findings, the science team believes that art forgery has been committed in the following studio/s:	**Yes**	**No**
Art studio in the forest		
Art studio at the lake		
Art studio at the sea		

TASK E

1. Facts about....

1.1. Tick the appropriate statements in the table "Facts about….". (24 Marks)

	Table "Facts about…."	correct	incorrect
Facts about colours	Jeans have originally been dyed with plant dye.		
	Colour of materials depends partly on the spectral composition of the incoming light		
	Artifical blood is a chemical compound that contains chromium		
Facts about crystal	Kidney stones can partly be composed of calcium oxalate.		
	Diffraction of X-rays is used to determine the structure of crystals		
	Rock crystal is pure Si(IV)oxide and therefore not classified as a crystal		
Facts about blood	Compared to blood plasma, the isotonic sodium chloride solution is an isoosmotic solution.		
	Blood pressure of 114 mm Hg corresponds to a pressure of a 1.5 m high in a water column		
	The chromium (VI) concentration in human whole blood is ~100 µg/L		
Facts about light	The following molecules serve as photoreceptors: Chlorophyll in photosynthesis, phytochrome in growth regulation, rhodopsin in the vision process.		
	Molecules with high symmetry show optical activity.		
	Lambert-Beer's law is valid only for red solutions		